**IN THE UNITED STATES
PATENT AND TRADEMARK OFFICE**

PATENT APPLICATION

Eric C Beck
Markus Rupp

CASE 3-16

Serial No. 09/772359 **Group Art Unit** 2667

Filed January 30, 2001

Examiner Rhonda L. Murphy

Title Optimal Channel Sounding System

**COMMISSIONER FOR PATENTS
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ALEXANDRIA, VA 22313-1450**

SIR:

Enclosed is an Appeal Brief in the above-identified application.

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Respectfully,

John B. MacIntyre

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Date: 9/22/06

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Beck 3-16

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Serial No. 09/772,359

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application

Inventor(s): E. Beck
M. Rupp
Case: 3-16
Serial No.: 09/772,359 **Group Art Unit:** 2667
Filed: January 20, 2001
Examiner: R. L. Murphy
Title: **Optimal Channel Sounding System**

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Appellant's Brief Under 37 C.F.R. 41.37

This is an appeal to the Board of Patent Appeals and Interferences from the Final Rejection dated January 26, 2006.

A Notice of Appeal was timely filed.

Real Party in Interest

The real party in interest is Lucent Technologies Inc.

Related Appeals and Interferences

There are no related appeals or interferences.

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Status of Claims

Claims 1-38 are pending in the application.

Claims 1-10, 15, 24, 25, 33, 37, and 38 are rejected under 35 U.S.C. 103 as being made obvious by United States Patent No. 6,483,866 issued to Suzuki on November 19, 2002 in view of United States Patent No. 6,907,270 issued to Blanz on June 14, 2005.

Claims 11-14, 16-23, 26-32, and 34-36 are apparently rejected under 35 U.S.C. 103(a) as being unpatentable over Suzuki and Blanz in further combination with one or more various additional references.

A copy of the claims under appeal as now presented are appended to this brief in Appendix A.

Status of Amendments

All amendments to the claims have been entered.

Summary of Claimed Subject Matter

In order to make the overview set forth hereinbelow concise, and thus useful to the members of the Board, the Appellants note that only some of the disclosure from the Specification that supports the independent claims has been included in the overview. Thus, the disclosure that has been included, or referred to herein, represents only a portion of the total disclosure set forth in the specification that supports the independent claims.

Thus, the following is only meant to indicate what applicant believes presently is the minimum support in the specification that supports the independent and dependent claims as required by 37 C.F.R. 41.37(c)(v), but not all of the support available in the specification has necessarily been included herein.

As noted in the Background of the Invention section of the specification at page 1, lines 6-25, channel sounding is the process of measuring the characteristics of a channel so as to design a communication system that best takes advantage of the determined characteristics of the channel. This is typically done by having a transmitter transmit a signal that is made up of a repeating known training sequence and then processing the signal after it has passed through the channel at a receiver to develop an estimate of the channel characteristics. It is well known in the art that the Cramer-Rao bound is the limit to which channel characteristics may be estimated using linear channel sounding techniques. One method of estimating the channel characteristics is to employ the

so-called "least squares method". Doing so, gives conditions that the training sequence must meet in order to achieve the Cramer-Rao bound.

One condition that, if met, will yield a channel estimate at the Cramer-Rao bound is that the training sequence be orthogonal. However, the art was typically only aware of orthogonal sequences that were very short, e.g., no greater than 16 symbols, or several sequences that were much longer, at lengths of $(2^n)^2$, where n in an integer. The use of the known short sequences was of no value, because they cannot be used to measure channels with large delay spread, such as is required for wideband communication. The use of the known long sequences was also of no value, because they require complicated modulation schemes that are not practical to implement. Thus orthogonal sequences were not used in the art and no practical study was devoted to the use of orthogonal sequences for channel sounding.

Applicants recognized that the use of periodic orthogonal sequences can not only allow the Cramer-Rao bound to be met in estimating the channel, but they permit considerable simplification of the structure necessary to perform the channel sounding. For example the implementation of the least-square method can be simplified, and post filtering to improve the quality of the estimate can also be simplified.

Applicants also recognized that the channel filtering, e.g., raised cosine filtering, performed in the prior art when pseudo-orthogonal sequences, such as M-sequences, which was the best the prior art could achieve, were transmitted is unnecessary when using orthogonal sequences according to the invention due to the periodic nature of the orthogonal sequences employed. This is because a periodic sequence is represented perfectly by a Fourier series without approximation. Therefore the interpolation performed to facilitate reconstruction to a continuous time, e.g. analog, signal can be computed perfectly in the frequency domain as an extension of the Fourier series describing the sequence, followed by an inverse Fourier series transform to express the sequence in the time domain. The interpolation may also be done just as accurately in the time domain because of the duality between the frequency and time domains.

The periodic orthogonal sequences are generated by using the techniques disclosed in the previously filed copending application Serial No. 09/648,983—which was incorporated by reference in the instant specification as if fully set forth therein—to develop orthogonal sequences of substantially arbitrary length as a function of first and second existing orthogonal sequences and using such orthogonal sequences for channel sounding in lieu of M-sequences.

The techniques of the invention are especially suited to systems that use multiple antennas at the transmitter and multiple antennas at the receiver, these being so called multiple-input multiple-output (MIMO) systems.

Claim 1 relates to a transmitter using a new orthogonal sequence that is modulated by a modulator, the new orthogonal sequence being supplied from a source and having been developed as a function of first and second existing orthogonal sequences and being such that it would have a perfectly white spectrum if it were to be repeated an infinite number of times. FIG. 1 shows transmitter 131 and FIG. 5 shows transmitter 531, which support this claim, as does the corresponding sections of the specification starting at page 4, line 32 through page 5, line 24 and page 7, line 33 through page 8, line 26.

Claim 6 relates to a transmitter of a similar type to that of claim 1 but which is defined in means plus function format. Claim 6 is supported by transmitter 131 and transmitter 531 and the corresponding sections of the specification starting at page 4, line 32 through page 5, line 24 and page 7, line 33 through page 8, line 26. The means for repeatedly supplying an orthogonal sequence is support by orthogonal sequence source 101 of FIG. 1 and orthogonal sequence source 501 of FIG. 5, while the means for modulating is supported modulator 103 of FIG. 1 and modulators 503 of FIG. 5. The corresponding sections of the specification are found at page 4, line 32 through page 5, line 24 and page 7, line 33 through page 8, line 26

Claim 10 relates to a receiver for use in performing channel sounding that does not require channel filtering. Claim 10 is supported by receiver 133 of FIG. 1, FIGs. 2-4, and receiver 533 of FIG. 5 and the corresponding sections of the specification starting at page 5, line 25 through page 9, line 12.

Claims 15 and 24 are each system claims that include a transmitter similar to that recited in claim 1 and a receiver similar to that recited in claim 10. Claims 15 and 24 are supported by FIGs. 1-5 and the corresponding sections of the specification starting at page 4, line 32 through page 9, line 12.

Claim 18 relates to a transmitter using a plurality of new orthogonal sequences that are each a version of an original orthogonal signal and each of which is modulated by a modulator, where the original orthogonal sequence was developed as a function of first and second existing orthogonal sequences and being such that it would have a perfectly white spectrum if it were to be repeated an infinite number of times. Claim 18 is supported by transmitter 531 of FIG. 5 and the corresponding sections of the specification starting at page 7, line 33 through page 8, line 26.

Claim 25 relates to a transmitter of a similar type to that of claim 18 but which is defined in means plus function format. Claim 25 is supported by transmitter 531 of FIG.

5 and the corresponding sections of the specification starting at page 7, line 33 through page 8, line 26. More specifically, the means for repeatedly supplying a plurality of orthogonal sequences is supported by orthogonal sequence source 501 and delay elements 523.

Claim 29 relates to a receiver similar to that of claim 10 for use in performing channel sounding that employs a plurality of demodulators and a plurality of finite impure response filters (FIR) but does not require channel filtering. Claim 29, which is defined in means plus function format, is supported by receiver 133 of FIG. 1, FIG. 2, FIGs. 3 and 4, and receiver 533 of FIG. 5 and the corresponding sections of the specification starting at page 5, line 25 through page 9, line 12.

Claim 33 relates to a receiver for use in performing channel sounding that includes means for demodulating and means for implementing least squares algorithm. Claim 33 is supported by receiver 133 of FIGs. 1, 3 and 4, FIG. 2, and receiver 533 of FIG. 5 and the corresponding sections of the specification starting at page 5, line 25 through page 9, line 12. Structure supporting the means for demodulating includes demodulators 109 and 509. Structure support the means for implementing includes FIG filters 111 and 511, an exemplary embodiment of which is made up of the elements of FIG. 2.

Claim 34 is a system claim for a MIMO system that include a transmitter similar to that recited in claim 18 and a receiver similar to that recited in claim 29. Claim 34 is supported by FIG. 5 and the corresponding sections of the specification starting at page 7, line 33 through page 9, line 12.

Claim 37 is a method claim which is similar to apparatus claim 1 but which further requires that the modulated carrier signal that is generated be recorded. FIG. 1 shows transmitter 131 and FIG. 5 shows transmitter 531, which support this claim, as does the corresponding sections of the specification starting at page 4, line 32 through page 5, line 24 and page 7, line 33 through page 8, line 26.

Grounds of Rejection to be Reviewed on Appeal

I. Are claims 1-10, 15, 24, 25, 33, 37, and 38 properly rejected under 35 U.S.C. 103 as being made obvious by United States Patent No. 6,483,866 issued to Suzuki on November 19, 2002 in view of United States Patent No. 6,907,270 issued to Blanz on June 14, 2005.

Serial No. 09/772,359

II. Are claims 11-14, 16-23, 26- 32, and 34-36 which are apparently rejected under 35 U.S.C. 103(a) as being unpatentable over Suzuki and Blanz in further combination with one or more various additional references, properly rejected.

Argument

Issue I – Rejection of claims 1-10, 15, 24, 25, 33, 37, and 38

1-10, 15, 24, 25, 33, 37, and 38 are rejected under 35 U.S.C. 103 as being made obvious by United States Patent No. 6,483,866 issued to Suzuki on November 19, 2002 in view of United States Patent No. 6,907,270 issued to Blanz on June 14, 2005. Regarding Suzuki, the Office Action states that elements RG1 and FR1 are a source of an orthogonal sequence which is repeatedly supplied as an output, as recited by applicants' claims, the orthogonal sequence having been developed as a function of first and second existing orthogonal sequences. The Office Action then recognizes that Suzuki fails to explicitly disclose a perfectly white spectrum should the orthogonal sequence be repeated an infinite number of times. However, continues the Office Action, Blanz teaches a white spectrum upon repeating the orthogonal sequences. Thus, concludes the Office Action, that one of ordinary skill in the art would modify Suzki's system by including orthogonal sequences that would produce a white spectrum in order to retrieve the desired signal at the receiving end.

In response to applicants' previous comments, the Office Action states that it understands that Blanz's white spectrum is coming from a white noise source, and it is known that white noise exists. Furthermore, continues the Office Action, the spectrum described in Blanz is a white spectrum, and it would be obvious to supply the white noise to the transmitter. In this regard, the Office Action concludes that the white noise spectrum provided at the transmitter would have the same effect as if the white noise were provided in the channel.

This ground of rejection is respectfully traversed for the following reasons.

The Office Action has completely mischaracterized Blanz, and has drawn incorrect conclusions therefrom even had the Blanz reference been properly characterized by the Office Action. First and foremost, Blanz does **not** teach a white spectrum resulting

upon repeating orthogonal sequences. (See column 8, line 58 to column 7, line 23.) Rather, as to white noise, Blanz merely takes into account the possibility that there may be white noise in the channel being estimated by Blanz, which is represented by the noise vector **n**.

In this regard, applicants note that, as is well-known, noise is **naturally occurring** and generally **undesirable**, but if it exists, it must be characterized and accounted for as part of the channel to accurately represent the channel. This is because any noise that exists in a channel gets unavoidably added to each transmitted signal that passes through that channel simply as a natural result of the transmitted signal passing through the channel, i.e., by superposition. Thus, the naturally occurring and undesirable white noise in Blanz that has become intermixed with the desired signal is **not** taught as being from any particular "white noise source", the Office Action's statement to the contrary notwithstanding. Rather, Blanz is merely explaining how to characterize a "noisy" channel in which the **naturally occurring** noise of the channel happens to have a substantially white spectrum. Nevertheless, note still that the white noise present in the channel of Blanz is regarded as a **bad** thing, as noise tends to be regarded as bad.

Since the white noise in the channel of Blanz is considered to be **bad**, Blanz most certainly does **not** teach or suggest to supply white noise at the transmitter, as proposed by the Office Action. Indeed, the opposite is true. At the transmitter, one generally wants to supply only signal, **not** noise. In fact, typically, the more noise that there is, the more of it winds up getting added to the transmitted signal, and the harder it is at the receiver to detect the transmitted signal, which is why noise is **bad**. Hence, one of ordinary skill in the art would **not** include a white noise source at the transmitter as proposed by the Office Action.

Furthermore, even if 1) Blanz had suggested a white noise source, and even if 2) such a white noise source were to be located at the transmitter, neither of which is true in the slightest, there is still **no** teaching or suggestion in Blanz that such a white noise source be, or even that it is desirable that the white noise source be, a new orthogonal sequence that was developed as a function of first and second existing orthogonal sequences and which would have a perfectly white spectrum were it were to be repeated

an infinite number of times. Indeed, such a new white noise source would **not** be suggested. Rather, an already known conventional white noise source could at best be suggested. But of course, as already explained, **no** man-made white noise source is actually suggested by Blanz. To the contrary, Blanz does **not** teach to add white noise to the signal at any point, because the noise **occurs naturally** in the channel and is **bad**.

It has already been settled, and the Office Action agrees at least, that there is **no** indication that any sequence that is produced in Suzuki as the combination of two existing orthogonal sequences has a perfectly white spectrum should such a sequence be repeated an infinite number of times. In fact, applicants maintain that Suzuki does not teach orthogonal sequences as all, but rather produces merely pseudo-orthogonal signals (which is at best similar to, but not actually orthogonal). Thus, Suzuki **fails** to teach a source of an orthogonal sequence which is repeatedly supplied, the orthogonal sequence having been developed as a function of first and second existing orthogonal sequences and being such that it would have a perfectly white spectrum were it to be repeated an infinite number of times, as required by applicants' independent claims 1, 6, 15, 18, 24, 25, 34, and 37.

Blanz does **not** correct this deficiency.

Blanz does **not** teach the generation of any white spectrum signal, or the desirableness of same. As explained above, notwithstanding the Office Action's statement to the contrary, the only mention of "white" in Blanz is in connection with **undesired noise** that naturally exists in a channel being estimated. Thus, noise, even if it were to correspond to applicants' repeated orthogonal signal, is **not** in any way "supplied", as is required of the repeated orthogonal sequence recited by applicants' claims. In other words, Blanz does **not** teach or suggest intentional generation and supplying of a white spectrum, and certainly **not** generation and supplying of a white spectrum in connection with a supplied repeating orthogonal sequence **signal**.

Furthermore, even with impermissible hindsight from applicants' invention, if one were to combine Suzuki with Blanz, the result would be some pseudo-orthogonal signal, derived in a very different manner from applicants' actually orthogonal signal, to which white noise is naturally added as the pseudo-orthogonal signal travels through the

channel. Note, importantly, that the addition of white noise to the signal because of the nature of the channel does **not** make the signal have a white spectrum. It simply means that white noise is riding on the signal distorting it, assuming that the signal has a greater amplitude than the white noise.

Additionally, applicants' claims 10, 29, and 33 each requires that there is no channel filtering performed between the demodulator and the FIR filter implementing a least squares algorithm. Such filtering is **implicitly required**, as is well known by those of ordinary skill in the art, even if not explicitly shown in a transmitter diagram, when sequences that do not have a perfectly white spectrum should they be repeated an infinite number of times are employed, such as in Suzuki. Furthermore, in Suzuki there is no teaching of an FIR filter implementing a least squares algorithm. Thus, the combination of Suzuki and Blanz does not teach or suggest all of the elements of applicants' independent claims 10, 29, and 33.

Thus, all of applicants' independent claims are allowable over Suzuki and Blanz under 35 U.S.C. 103. Since all of the dependent claims that depend from the allowable independent claims include all the limitations of the respective independent claim from which they ultimately depend, each such dependent claim is also allowable over the combination of Suzuki and Blanz under 35 U.S.C. 103.

Issue II – Rejection of claims 11-14, 16-23, 26-32, and 34-36

Dependent claims 11-14, 16-23, 26-32, and 34-36 are apparently rejected under 35 U.S.C. 103(a) as being unpatentable over Suzuki and Blanz in combination with one or more various additional references. Applicants say "apparently" in that these are all dependent claims, and so all of the limitations from the independent claim must be met as well as the additional limitations added by the dependent claim. Since all the rejections of the independent claims rely on the combination of Suzuki and Blanz, applicant assumes that the Office Action intended to include Blanz in the combinations on which the rejection is based. If not, each of the rejections are merely copied over from the prior Office Action, and were already traversed by applicant in their prior amendment.

Assuming applicants are correct, they note that each of the grounds of rejection of these dependent claims is predicated on the validity of the rejections of the independent claims under 35 U.S.C. 103 given Suzuki in combination with Blanz. Since those rejections have been traversed, as described hereinabove, and there is no argument put forth by the Office Action that any of the additional references supplies that which is missing from the combination of Suzuki and Blanz, to render the independent claims obvious, these grounds of rejection cannot be maintained.

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Conclusion

In view of the foregoing, it is submitted that the Examiner is in error. It is, accordingly, respectfully requested that the rejection of claims 1-38 be reversed and the application passed to issue.

Respectfully,

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By John B. MacIntyre

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Date: 9/22/06

Serial No. 09/772,359

Claims Appendix

1. A transmitter for use in performing channel sounding, comprising:

a source of an orthogonal sequence which is repeatedly supplied, said orthogonal sequence having been developed as a function of first and second existing orthogonal sequences and being such that said orthogonal sequence would have a perfectly white spectrum were said orthogonal sequence to be repeated an infinite number of times; and

a modulator for producing a modulated signal by modulating a carrier signal by said orthogonal sequence, said modulator being coupled to said source;

whereby no channel filtering is required between said source and said modulator to reduce out-of-band emissions caused by said source.

2. The invention as defined in claim 1 wherein said source of an orthogonal sequence is a memory which stores said orthogonal sequence.

3. The invention as defined in claim 1 wherein said source of an orthogonal sequence is a sequence generator.

4. The invention as defined in claim 1 further comprising an antenna coupled to said modulator for broadcasting said modulated signal.

5. The invention as defined in claim 1 wherein no filtering is performed between said source and said modulator.

6. A transmitter for use in performing channel sounding, comprising:

means for repeatedly supplying an orthogonal sequence that is a function of first and second existing orthogonal sequences and has a perfectly white spectrum should said orthogonal sequence be repeated an infinite number of times; and

means for modulating a carrier signal by said orthogonal sequence, said means for modulating being coupled to said means for repeatedly supplying;

whereby no channel filtering to reduce out-of-band emissions caused by said means for supplying is required between said means for repeatedly supplying and said means for modulating.

7. The invention as defined in claim 6 wherein said means for repeatedly supplying is a memory which stores said orthogonal sequence.

8. The invention as defined in claim 6 wherein said means for repeatedly supplying is a sequence generator.

9. The invention as defined in claim 6 further comprising means for broadcasting said modulated signal.

10. A receiver for use in performing channel sounding, comprising:

a demodulator for demodulating a received version of an orthogonal sequence that modulates a carrier and which is repeated at least once and was derived as a function of first and second existing orthogonal sequences to produce a baseband demodulated received orthogonal sequence; and

a finite impulse response (FIR) filter implementing a least squares algorithm to produce a channel estimate, said FIR filter being coupled to receive said demodulated received orthogonal sequence from said demodulator;

whereby no channel filtering is performed between said demodulator and said FIR filter to reduce out-of-band noise inherently resulting from an orthogonal sequence that modulated a carrier for transmission by a transmitter to ultimately become said received version after passing through a channel and being received.

11. The invention as defined in claim 10 wherein coefficients of said FIR filter are complex conjugate values of said orthogonal sequence.

12. The invention as defined in claim 10 further comprising an averager for averaging a plurality of channel estimates produced by said FIR filter.

13. The invention as defined in claim 10 further comprising a bandlimiting filter coupled between said demodulator and said FIR filter for reducing out-of-band noise that was introduced into said baseband demodulated received orthogonal sequence through said channel or at said receiver.

14. The invention as defined in claim 10 further comprising means for receiving a wirelessly broadcast version of said modulated version of a orthogonal sequence and converting said modulated version of said orthogonal sequence into an electrical representation.

15. A system for use in performing channel sounding, comprising:

a transmitter, said transmitter including

a source of an orthogonal sequence which is repeatedly supplied as an output, said orthogonal sequence (i) having been developed as a function of first and second existing orthogonal sequences and (ii) having a perfectly white spectrum when repeated an infinite number of times;

a modulator for modulating a carrier signal by said orthogonal sequence, said modulator being coupled to said source ;

whereby no channel filtering is required between said source and said modulator to reduce out-of-band emissions caused by said source; and

a receiver including

a demodulator for demodulating a received modulated version of said orthogonal sequence that modulates a carrier and was transmitted by said transmitter;

a finite impulse response (FIR) filter implementing a least squares algorithm for developing an estimate of the channel characteristic, said FIR filter being coupled to receive said demodulated orthogonal sequence from said demodulator;

whereby no channel filtering is performed between said demodulator and said FIR filter to reduce out-of-band noise inherently resulting from said orthogonal sequence prior to its being supplied to said modulator.

16. The invention as defined in claim 15 wherein said demodulated training sequence is filtered using a band-limiting filter to eliminate out of band noise picked up at said receiver prior to being received by said FIR filter, there being no such band-limiting filter in said transmitter.

17. The invention as defined in claim 15 wherein said receiver further comprises an averaging filter for averaging said estimate of the channel characteristic developed by said FIR filter.

18. A transmitter for use in performing channel sounding, comprising:

a supplier of a plurality of orthogonal sequences each of which is a version of an original orthogonal sequence, each of said plurality of orthogonal sequences being repeatedly supplied, said original orthogonal sequence having been developed as a function of first and second existing base orthogonal sequences and having a perfectly white spectrum should said original orthogonal sequence be repeated an infinite number of times; and

a plurality of modulators for producing a plurality of modulated signals by modulating a carrier signal by said each of said plurality of orthogonal sequences, said modulators being coupled to said supplier so that no channel filtering to reduce out-of-band emissions caused by any of said orthogonal signals is performed on said orthogonal sequence between said supplier and any of said modulators.

19. The invention as defined in claim 18 wherein said supplier of a plurality of orthogonal sequences comprises a source of said original orthogonal sequence and at least one delaying element.

20. The invention as defined in claim 18 wherein said plurality of orthogonal sequences include at least said original orthogonal sequence and at least one delayed version of said original orthogonal sequence.

21. The invention as defined in claim 18 further comprising a plurality of antennas, each of said antennas being coupled to a respective one of said modulators.

22. The invention as defined in claim 18 wherein said plurality of orthogonal sequences include at least said original orthogonal sequence and at least two delayed version of said original orthogonal sequence, wherein the delay between each orthogonal sequence of said plurality of orthogonal sequences is substantially equal.

23. The invention as defined in claim 18 wherein said plurality of orthogonal sequences include at least said original orthogonal sequence and at least two delayed version of said original orthogonal sequence, wherein the delay between each orthogonal sequence of said plurality of orthogonal sequences is not substantially equal.

24. A system for use in performing channel sounding, comprising:

a transmitter, said transmitter including

a source of an orthogonal sequence which is repeatedly supplied as an output, said orthogonal sequence having been developed as a function of first and second existing orthogonal sequences and having a perfectly white spectrum should said original orthogonal sequence be repeated an infinite number of times;

a modulator for modulating a carrier signal by said orthogonal sequence, said modulator being coupled to said source;

whereby no channel filtering is required between said source and said modulator to reduce out-of-band emissions; and

a receiver including

a demodulator for demodulating a received modulated version of said orthogonal sequence that modulates a carrier and was transmitted by said transmitter;

a finite impulse response (FIR) filter implementing a least squares algorithm for developing an estimate of the channel characteristic, said FIR filter being coupled to receive said demodulated orthogonal sequence from said demodulator without passing through a filter that has a corresponding filter function in said transmitter.

25. A transmitter for use in performing channel sounding, comprising:

means for repeatedly supplying a plurality of orthogonal sequences that are each a version of an original orthogonal sequence that is a function of first and second existing basic orthogonal sequences, each of said plurality of orthogonal sequences having a perfectly white spectrum when repeated an infinite number of times; and

means for modulating each of a plurality of identical carrier signals by a respective one of said plurality of orthogonal sequences, each of said means for modulating being coupled to said means for repeatedly supplying so that no channel filtering to reduce out-of-band emissions is performed on any of said plurality of orthogonal sequences between said source and said modulator.

26. The invention as defined in claim 25 further comprising a plurality of means for broadcasting said modulated signal each of said means for broadcasting being coupled to a respective one of said means for modulating.

27. The invention as defined in claim 25 wherein said plurality of orthogonal sequences include at least said original orthogonal sequence and at least two delayed version of said original orthogonal sequence, wherein the delay between each orthogonal sequence of said plurality of orthogonal sequences is substantially equal.

28. The invention as defined in claim 25 wherein said plurality of orthogonal sequences include at least said original orthogonal sequence and at least two delayed version of said original orthogonal sequence, wherein the delay between each orthogonal sequence of said plurality of orthogonal sequences is not substantially equal.

29. A receiver for use in performing channel sounding, comprising:

a plurality of demodulators, each of said demodulators demodulating a respective plurality of received versions of an original orthogonal sequence that each modulates a carrier and which is repeated at least once and was derived as a function of first and second existing basic orthogonal sequences; and

a plurality of finite impulse response (FIR) filters implementing a least squares algorithm to produce a plurality of channel estimates, one for each of said received versions of said original orthogonal sequence of said plurality, each of said FIR filters

being coupled to receive its respective plurality of demodulated orthogonal sequences from a respective one of said demodulators without any channel filtering to reduce out-of-band emissions inherently resulting from said versions of said original orthogonal sequence that modulated said carrier to ultimately become said received versions after passing through a channel and being received being performed between said demodulator and said respective associated FIR filter.

30. The invention as defined in claim 29 further comprising a demultiplexer for separating out each channel estimate supplied as an output by the one of said FIR filters to which said demultiplexer is coupled.

31. The invention as defined in claim 29 further comprising a bandlimiting filter coupled between at least one of said demodulators and its associated respective one of said FIR filters for reducing out-of-band noise that was introduced into said baseband demodulated received orthogonal sequence through said channel or at said receiver.

32. The invention as defined in claim 29 further comprising an averager for averaging a plurality of channel estimates produced by the one of said FIR filters to which said averager is coupled.

33. A receiver for use in performing channel sounding, comprising:

means for demodulating a received version of an orthogonal sequence that modulates a carrier and which is repeated at least once and was derived as a function of first and second existing orthogonal sequences; and

means for implementing a least squares algorithm using finite impulse response (FIR) filtering to produce a channel estimate, said means for implementing being coupled to receive said demodulated orthogonal sequence from said means for demodulating without any channel filtering being performed between said means for demodulating and said means for implementing.

34. A system for use in performing channel sounding, comprising:

a transmitter, said transmitter including

a supplier of a plurality of orthogonal sequences each of which is a version of an original orthogonal sequence, each of said plurality of orthogonal sequences being repeatedly supplied, said original orthogonal sequence (i) having been developed as a function of first and second existing base orthogonal sequences and (ii) having a perfectly white spectrum when repeated an infinite number of times; and

a plurality of modulators for producing a plurality of modulated signals by modulating a carrier signal by said each of said plurality of orthogonal sequences, said modulators being coupled to said source so that no channel filtering to reduce out-of-band emissions caused by said orthogonal sequences is performed on said orthogonal sequences between said supplier and said modulators; and

a receiver including

a plurality of demodulators, each of said demodulators demodulating a respective plurality of received versions of said original orthogonal sequence that each modulates said carrier; and

a plurality of finite impulse response (FIR) filters implementing a least squares algorithm to produce a plurality of channel estimates, one for each of said received versions of said original orthogonal sequence of said plurality, each of said FIR filters being coupled to receive its respective plurality of demodulated orthogonal sequences from a respective one of said demodulators without any channel filtering to reduce out-of-band emissions inherently resulting from said versions of said original orthogonal sequence that modulated said carrier to ultimately become said received versions after passing through a channel and being received being performed between said demodulator and said respective associated FIR filter.

35. The invention as defined in claim 34 further comprising a plurality of demultiplexers, each of said demultiplexers separating out each channel estimate supplied as an output by the one of said FIR filters to which it is coupled.

36. The invention as defined in claim 34 further comprising a bandlimiting filter coupled between at least one of said demodulators and its associated respective one of said FIR filters for reducing out-of-band noise that was introduced into said baseband demodulated received orthogonal sequence through said channel or at said receiver.

37. A method for use in performing channel sounding, comprising the steps of:

repeatedly supplying an orthogonal sequence that (i) is a function of first and second existing orthogonal sequences and (ii) has a perfectly white spectrum when repeated an infinite number of times;

modulating a carrier signal by said orthogonal sequence, said means for modulating being coupled to said means for repeatedly supplying;

whereby no channel filtering to reduce out-of-band emissions is required between said means for repeatedly supplying and said means for modulating; and

recording said modulated carrier signal.

38. The invention as defined in claim 37 further comprising the step of playing back said recorded modulated carrier signal.

Evidence Appendix

Serial No. 08/866,754

Related Proceedings Appendix